DOCUMENT RESUME

ED 166 226 95 TM 008 197

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TITLE	An Exploratory Application of New Techniques for Evaluating Complex Peer Process Models. Report No. 247.
INSTITUTION	Johns Hopkins Univ., Baltimore, Md. Center for Social Organization of Schools.
SPONS AGENCY	National Inst. of Education (DHEW), Washington, D.C.
PUB DATE	Feb 78
CONTRACT	NE-C-00-3-0114
NOTE	55p.
EDRS PRICE	MF-$0.83 HC-$3.50 Plus Postage.
DESCRIPTORS	Academic Achievement; Critical Path Method; Educational Research; *Mathematical Models; *Peer Influence; Peer Relationship; Predictor Variables; *Research Methodology; Senior High Schools; Social Science Research
IDENTIFIERS	Causal Inferences

ABSTRACT

Recent theoretical and empirical study has considerably refined knowledge as to the dynamics of peer processes operative within secondary schools, but has tended to neglect models incorporating reciprocal effects. This situation results partly from a scarcity of appropriate data, and partly from limitations of older methodologies of estimating such models. This project makes use of rich survey data, including sociometric information and actual peer responses, and applies some recently developed estimation techniques to estimate the parameters, and the relative predictive power, of two alternative models for the influences of peers on academic achievement. The estimations are complicated by the appearance of unusual patterns in the data. However, they tend to indicate a better fit of the conceptualization which postulates direct reciprocal influences of each student's achievement on that of his peers, in contrast to an alternative model in which achievements depend only on the values of self and peers. In addition to the substantive results, the report also describes some methodological issues and comments on them. (Author/CTM)

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ED166226

Report No. 247
February 1978

AN EXPLORATORY APPLICATION OF NEW TECHNIQUES FOR EVALUATING COMPLEX PEER PROCESS MODELS

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Published by the Center for Social Organization of Schools, supported in part as a research and development center by funds from the United States National Institute of Education, Department of Health, Education and Welfare. The opinions expressed in this publication do not necessarily reflect the position or policy of the National Institute of Education, and no official endorsement by the Institute should be inferred.

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Introductory Statement

The Center for Social Organization of Schools has two primary objectives: to develop a scientific knowledge of how schools affect their students, and to use this knowledge to develop better school practices and organization.

The Center works through three programs to achieve its objectives. The Policy Studies in School Desegregation program applies the basic theories of social organization of schools to study the internal conditions of desegregated schools, the feasibility of alternative desegregation policies, and the interrelation of school desegregation with other equity issues such as housing and job desegregation. The School Organization program is concerned with authority-control structures, task structures, reward systems, and peer group processes in schools. It has produced a large-scale study of the effects of open schools, has developed the Teams-Games-Tournament (TGT) instructional process for teaching various subjects in elementary and secondary schools, and has produced a computerized system for school-wide attendance monitoring. The School Process and Career Development program is studying transitions from high school to post secondary institutions and the role of schooling in the development of career plans and the actualization of labor market outcomes.

This report, prepared by the School Organization Program, investigates the processes through which peers may influence one another's academic achievement.

ABSTRACT

Recent theoretical and empirical study has considerably refined knowledge as to the dynamics of peer processes operative within secondary schools, but has tended to neglect models incorporating reciprocal effects. This situation results partly from a scarcity of appropriate data, and partly from limitations of older methodologies of estimating such models. This project makes use of rich survey data, including sociometric information and actual peer responses, and applies some recently developed estimation techniques to estimate the parameters, and the relative predictive power, of two alternative models for the influences of peers on academic achievement. The estimations are complicated by the appearance of unusual patterns in the data. However, they tend to indicate a better fit of the conceptualization which posits direct reciprocal influences of each student's achievement on that of his peers, in contrast to an alternative model in which achievements depend only on the values of self and peers. In addition to the substantive results, the report also describes some methodological issues and comments on them.

1. Introduction

For analytic purposes, sociologists and economists have begun to represent school productivity processes by models comprised of simultaneous linear equations (Solmon, 1975; Wachtel, 1975; Sewell and Hauser, 1975), where each equation describes the behavior of an important outcome variable or intermediating variable. Any such model defines one specific theory of the relations among school inputs, school operating patterns, and school outcomes--the school productivity process. The work described in this report concentrates on one species of productivity model--those focusing on student peer relations as distinct sources of influence on student outcomes and as mediators of the influence of personal backgrounds and of the larger school setting. These issues are important for two reasons. First, peer relations have been shown to relate closely to various student outcomes, and thus are potentially sizeable influences on students (Coleman, 1961; Duncan, Haller and Portés, 1968; McDill and Rigsby, 1973). Second, such peer relations have been a generally neglected arena for policy, but one in which intervention perhaps may be accomplished with little capital expenditure, simply by making rather modest changes in the ways schools operate.

2. Recent Theory and Research

A substantial body of sociological and social psychological research has accumulated over the past fifteen years on the dynamics of student interpersonal processes in schools. Much of it has focused on the important and varied ways in which peer characteristics impinge upon a student's educational values, plans, achievements, and attainments (Duncan, Haller, and Portés, 1968; Haller and Butterworth, 1960; Hout and Morgan,

1975; Kandel and Lesser, 1969; Picou and Carter, 1976; Williams, 1972; and Williams, 1975).

Using social reinforcement and social comparison/modeling theories of interpersonal behavior as frames of reference, McDill and associates (McDill, Meyers, and Rigsby, 1967; McDill, Rigsby, and Meyers, 1969; Rigsby and McDill, 1972; McDill and Rigsby, 1973; and Rigsby and McDill, 1975) have investigated social psychological factors as determinants of academic achievement, educational goals, and value orientations for a national sample of twenty high schools. Developing a distinction between distal and proximate influences in school settings, they constructed measures of social and academic climates within schools, at both the institutional (i.e., distal) and the interpersonal (i.e., proximate) levels. Each of these climate variables was shown in these earlier studies to exert an independent effect on the outcome variables. Moreover, part of the influence of the institutional climate factors was found to be mediated through more proximate mechanisms of interpersonal influence. Upon further analysis, a variety of familial, community, and school organizational variables were identified as contributing to both types of school social climate. This body of research has provided considerable insight into the mechanisms of social influence within school settings.

As the culmination of their earlier efforts at modeling the peer influence processes within secondary schools, McDill and his associates (Rigsby and McDill, 1972, pp. 317-319) advanced two alternative synthesizing frameworks outlining the mechanisms through which peers may affect the level of each other's academic achievement. Their argument led them

to prefer a specification in which the scholastic values held by a student and those held by his friends would jointly influence the level of academic achievement, after several other important factors are taken into account. As an alternative, they postulated a model in which a student's achievement depends directly on his own values, but not on those of his peers. In this latter model, however, there is a direct reciprocal effect of one student's achievement on the achievement of his peers and vice versa. The primary objective of the present report is to describe an empirical comparison of these two models. This comparison is done using techniques of statistical estimation not generally available when these conceptual frameworks were first formulated.

3. Structural Equations Techniques

Although the research described in the preceding section has made clearer the ways in which social structural aspects of schooling are related to socially relevant school outcomes, methodological improvement is possible in several respects. It has become apparent that the particular specifications used (the substantive model), the particular measurement definitions adopted (the measurement model), and the particular estimation technique employed, all may affect the analyses that are possible and thus influence the conclusions that are made.

Recently, sociologists have acquired several new techniques for the specification and estimation of complex (e.g., non-recursive) structural equation models. Such techniques include the methods developed within econometrics for estimating simultaneous equation systems, especially the instrumental variable approaches including two-stage least squares. Also important, however, is recent work by Karl Jöreskog and others

carried on under the general rubric of constrained covariance structure analysis. The computer program LISREL, and its associated definitions and perspective, is one important product of this work (Jöreskog, 1973; Jöreskog and Gruvaeus, 1976). The relevant features of the LISREL approach for our purposes are two: (1) like the two-stage least squares method, it allows the estimation of equation systems which are non-recursive and overidentified; (2) distinctively, it allows the analysis of a measurement model simultaneously with the structural model. Conceptually, this latter feature constitutes a major advance in overall coherence for the research analysis. In this project, we apply these new techniques.

4. Peer Process Models to be Compared

As already indicated, our point of departure in this report is two alternative substantive models of peer influence on one important school outcome, academic achievement. These representations were carefully developed, but were not explicitly operationalized or estimated in recent works by Rigsby and McDill (1972) and McDill and Rigsby (1973). The two models are shown in Figures 1 and 2 respectively. They differ in

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Figures 1 and 2 About Here

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subtle yet significant respects. Model A, shown in Figure 1, postulates that any observed correlation between the academic achievement of ego and that of his peer associates comes about through their mutual depen-

Figure 1

Hypothetical peer influences through scholastic values. (Model A)

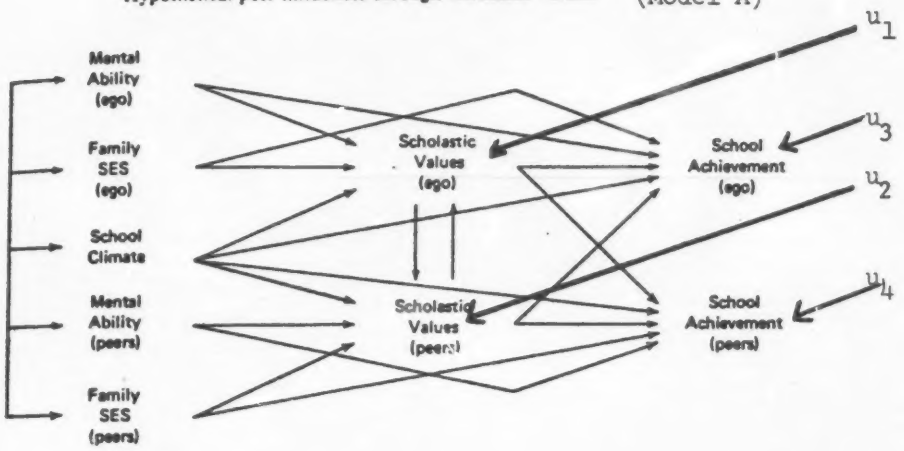
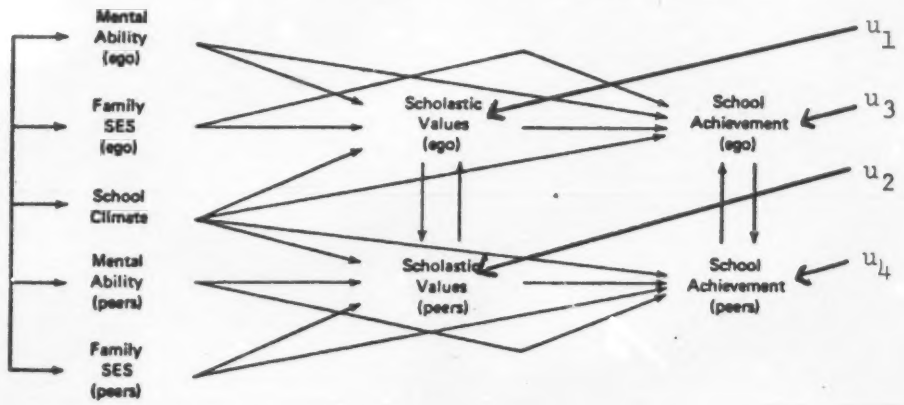


Figure 2

Hypothetical peer influences through scholastic values and achievement. (Model B)



dence upon scholastic values, background characteristics, and school climate, with peer's values influencing ego's achievement and vice versa. Model B, in Figure 2, on the other hand, postulates that the academic achievements of ego and those of his peers are directly reinforcing of one another even after their mutual dependence upon several prior determinants is taken into account. Additionally, however, Model B posits a somewhat more limited pattern of value influences, in that ego's values, as an example, can only affect other's achievement through their immediate relevance for ego's own achievement. That is, the possibility of direct peer influences on achievement entertained in Model A is excluded in this second model of social and interpersonal factors in school productivity. The originators of this pair of models believed Model A to be more plausible.

In both models the theoretical framework identifies three categories of input variables: (1) background characteristics of ego (mental ability and socioeconomic origins); (2) school level social climate; and (3) background characteristics of peer associates (i. e, mental ability of peers, socioeconomic origins of peers). Both diagrams postulate a reciprocal influence between the academic values held by ego and those held by his peer associates. They thus allow for the mediating role played by interpersonal relations in school productivity processes, as well as for the influence of the more distal school climate variable.

Both specifications are consistent with recent theory regarding the importance of social modeling and interpersonal processes in affecting academic achievement, but each implies somewhat different mechanisms.

The theory of social influence implied in Model A posits that peer networks of association are determiners of academic performance only insofar as they shape ego's and his peer's academic values. Model B, however, recognizes the possible importance of modeling, comparison, and tutoring effects through which peer relationships condition academic performance entirely independently of any socialization process that might affect academic values. Model B denies the direct influence of other's values on own achievements. This is debatable, but is an important aspect of the theoretical argument made in the earlier work.

The empirical analysis reported in the following sections compares these two substantive models using various operational definitions of the variables, and various sets of data. We undertake this in the expectation that it will enrich not only our understanding of how peer relations contribute to school productivity outcomes, but also that it will shed light on the advantages and limitations of the new statistical techniques of estimation being used.

These various tacks were pursued in large part because of the ambiguities and anomalies encountered in the initial estimations. At first thought, we suspected that the unexpected outcomes might be peculiar to the sample selected or to the quality of the data employed. Hence, instead of elaborating the models by considering multiple-indicator measurements (as had been our original plan) we undertook a series of quasi-independent replications. The replications helped show that the results are not peculiar to a single data set, but that the specific patterns in a data set are important. In short, we have discovered and explored some pitfalls inherent in the estimation of complex structural models.

The database used in these comparisons is the Twenty High Schools Survey data (McDill and Rigsby, 1973). These data are particularly suited for this analysis because they included rich sociometric-type questions about peer relations, and thus can yield direct measures of the peer characteristics and values. The data are described in detail in McDill and Rigsby (1973).

5. Results

5.1 Overview

Our original intent in this analysis was to begin by operationalizing the two models using single-item indexes for each of the conceptual variables, and then to refine the measurement aspect of the models by switching to multiple-item indicators, and using LISREL to estimate the parameters. However, because of complications that will be described, we have confined our analysis in the present report to operationalizations using single-item indicators only.

The two substantive models have been estimated on four variant datasets from the larger database. The estimation was carried out using LISREL and also using (where possible) two-stage least squares. Each model was estimated using alternative specifications on the structural disturbances, resulting in 20 estimations using LISREL and 12 using 2SLS.

Table 1 provides an overview of the estimations that have been done;

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Table 1 About Here

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Table 1

LISREL Results; Goodness of Fit of Several Peer Influence Analyses

	Model A No Reciprocal Achievement		Model B No Peer Values on Achievement	
10% of sample of all				
N = 1,741 mixed	1. x^2=145.13; 6 df; p=0.0000	2SLS	2. x^2=9.34; 6 df; p=0.1555	2SLS
N = 1,741 fixed	3. x^2=328.31; 8 df; p=0.0000	----	4. x^2=80.10; 8 df; p=0.0000	----
N = 1,741 free	5. not fully identified		6. x^2=0.56; 2 df; p=0.7565 #	2SLS
male seniors				
N = 594 mixed	7. x^2=51.33; 6 df; p=0.0000 #	2SLS	8. x^2=9.77; 6df; p=0.1348 #	2SLS
N = 594 fixed	9. x^2=126.37; 8 df; p=0.0000	----	10. x^2=42.53; 8 df; p=0.0000	----
N = 594 free	11. not fully identified		12. x^2=1.19; 2 df; p=0.5516 #	2SLS
female seniors				
N = 679 mixed	13. x^2=59.86; 6 df; p=0.0000	2SLS	14. x^2=6.18; 6 df; p=0.4035	2SLS
N = 679 fixed	15. x^2=122.90; 8 df; p=0.0000	----	16. x^2=27.52; 8 df; p=0.0006	----
N = 679 free	17. not fully identified		18. x^2=0.89; 2 df; p=0.6412 #	2SLS
male seniors				
N = 609 mixed	19. x^2=25.34; 6 df; p=0.0003	2SLS	20. x^2=17.90; 6 df; p=0.0065	2SLS
N = 609 fixed	21. x^2=78.64; 8 df; p=0.0000	----	22. x^2=27.35; 8 df; p=0.0006	----
N = 609 free	23. not fully identified		24. x^2=0.63; 2 df; p=0.7290 #	2SLS

Note: "#" indicates that the LISREL algorithm did not converge (IND = 4)
"x" indicates chi-square

N	Description
1,741	10% sample of all students; uses aggregate peer data.
594	50% sample of male seniors; uses aggregate peer data.
679	50% sample of female seniors; uses aggregate peer data.
609	50% sample of male seniors; uses choice #1 data; uses "personally admire brightness."

it shows, for each estimation, the chi-square overall measure of goodness of fit obtained from the LISREL program. The major substantive comparisons to be made from this table are those within any given line (row). The larger the p-value, the better the fit of that particular model to that data. As can be seen, Model B (involving direct reciprocal effects of ego's achievement on peers' achievement and vice versa) consistently fits better than Model A (which postulates that ego's values and peers' values both effect ego's achievement and peers' achievement, but that there is no direct reciprocal effect of achievement on achievement). This is the single most consistent result of the analysis, but needs to be discussed in some detail for a fuller appreciation of its import. Succeeding sections provide such discussion.

The better fit of Model B follows technically from the fact that the reduced form equations predict the MATH variables much better than they predict the ACADV variables. Thus, when an instrument for ACADV is used (either ACADVOWN or ACADVFRN), the explanatory power of the model is weakened. Thus, it may be less the substantive correctness of the direct effects in comparison to the effects of values, and more the weakness of the measurement of values (or perhaps their substantive elusiveness per se) that accounts for the relatively better overall fit of Model B. The interpretation of this fit in any event depends strongly on the interpretation of the ACADV variables and their role in the process.

5.2 Estimation Results Based on All Respondents

In choosing specific data sets on which to estimate the two alternative substantive models (i.e., Model A and Model B as shown in Figures 1 and

2), we made several tradeoffs between two criteria: (1) inclusiveness, and (2) the internal homogeneity and theoretical appropriateness of the subset of cases. The results presented first, which are based on a random sample of all the respondents, were chosen to maximize coverage. That is, this set of results is based on both male and female respondents, and on students in all four grades (freshman through senior). Partly to achieve economy of computation costs, but also to permit a replication within the same overall data base, we selected a random 10% sample of the more than 20,000 respondents. Pearson correlations for the variables appearing in the substantive model were then obtained on this sample, using a listwise deletion algorithm. This led to a 9 x 9 correlation matrix based on 1741 cases. That matrix is provided in Appendix A as Table A.1.

The initial analysis was confined to a specification in which only a single observed variable was used to measure each conceptual variable. For this set of calculations, the variables were operationalized as follows: (See McPill and Rigsby, 1973, for detailed information on the construction of all these measures.)

Label	Name	Description
ABSTOWN	Mental Ability (ego)	ego's score on the abstract reasoning test included in the THS project data collection.
FEDUOWN	Family SES (ego)	ego's report of his father's educational attainment, coded from 1 through 8.
CLIMATE	School Climate	school score (i.e., same for all students in the same school) on the "academic emulation" factor constructed in earlier work with this THS database. These scores are recoded to range from 1 through 4.

Label	Name	Description
ABSTFRN	Mental Ability (peers)	index based upon average score of up to four named friends on the abstract reasoning test.
FEDUFRN	Family SES (peers)	index based upon percentage of named friends whose fathers had completed at least some college.
ACADVOWN	Scholastic Values (ego)	ego's score on a six-item index of academic values developed in earlier work with the THS data.
ACADVFRN	Scholastic Values (peers)	index based on average score of up to four named friends on the six-item index of academic values.
MATHOWN	School Achievement (ego)	ego's score on a short test of mathematics knowledge included as part of the THS project data.
MATHFRN	School Achievement (peers)	average score of up to four named friends on short mathematics test.

Once the correlations had been obtained, estimation of the parameters of the two substantive models was undertaken using two alternative procedures: LISREL and two-stage least squares. Notice that in this situation, where each variable in the structural model is assumed to be measured without error, the LISREL approach is equivalent to an ordinary full information maximum likelihood estimation. Two-stage least squares is, if normality assumptions are made as to the disturbances, a limited-information maximum likelihood technique. Our purpose in this comparison was to obtain some sense of the behavior of LISREL in relation to the somewhat simpler and more familiar 2SLS technique. Initially we intended also to go beyond the single indicator mdoels and use multiple indicator specifications, but our original intentions were deflected owing to our

decision to pursue, and hopefully better understand, the peculiarities obtained during this first phase of the analysis. We felt it important to obtain more detailed evidence, from real data, as to the differences in estimated parameters that appear when these two methods are used; the analysis thus became partly a sensitivity study of the two estimation methodologies.

A further decision concerning the specification of Models A and B became necessary at this point. Both of these models contain four structural equations; each such equation includes a stochastic disturbance term. Our decision concerned restrictions to be placed on the variance-covariance matrix of these four structural disturbances, since they were left unspecified in McDill and Rigsby's original statement of these theories. (This matrix appears explicitly in the LISREL procedure as the "psi" matrix, and specification of its fixed and free elements is required.) Clearly, there was no reason to place any constraint on the variances of the disturbances (the diagonal elements of psi). These variances are obviously free parameters, to be estimated from the data along with the structural coefficients. However, the situation with respect to the 6 off-diagonal elements of the psi matrix is not so clear. Each of three alternative specifications can be defended as reasonable.

First, one might specify that all six of these covariances are fixed at zero. This is a 'strong' specification. Using it, the model can have a reasonably close fit to the data <u>only</u> if the explicitly postulated structural connections account for all the empirical covariation present among the four jointly dependent variables (ego's scholastic values; peer's

scholastic values; ego's achievement; and peers' achievement). This is indeed what we hope for, but hardly what we can expect, given the simplicity of the theory and the limitations of the measures. Thus, the specification is a theoretically aggressive or optimistic one. Anything less restrictive would be a recognition that our theory is, like most others, incomplete. Incidentally, it should be pointed out that, for these substantive models, there is no way to implement this particular specification on the disturbances using 2SLS. That is, in any equation, where any of the jointly dependent variables in the system appear as predictors on the right hand side of that equation, then the 2SLS approach will assume the disturbance from that equation has a free covariance with the disturbance into each included jointly dependent variable. This indicates one technical advantage of the LISREL approach--its greater flexibility in permitting different specifications of the structural model--even apart from its ability to handle measurement complications.

Second, one might take the opposite stance. That is, one might decide to impose no restrictions on any of the six disturbance covariances. This specification can be represented in LISREL simply by specifying that all 6 off-diagonal elements of the psi matrix are free. It is handled in the 2SLS approach by treating each of the four outcome variables as jointly dependent whenever it appears as a predictor in a structural equation.

Third, one might take an intermediate view. For example, one might specify that 2 of the 6 covariances are free to be estimated, and the other 4 are fixed at zero. In particular, one might postulate: (1) that

the covariance between disturbances into ego's values and into peers' values is nonzero; (2) that the covariance between disturbances into ego's achievement and peers' achievement is nonzero; but (3) that the other four covariances are fixed at zero. Such a specification would be justified by noting that the two "values" variables are similar to each other in content, and so may have additional common sources of covariance. Correspondingly, the two achievement variables are similar to each other in content, and likewise might have additional common sources of covariance. However, it would also be held that the relation between the values of ego and peer on the one hand, and the achievement of ego and peer on the other, is fully accounted for by the model. This specification can be represented in LISREL and in 2SLS. It is equivalent to treating VALUES as predetermined in each MATH equation.

Other specifications on the disturbances are of course possible. Notice that LISREL encourages, indeed compels, the analyst to think seriously about the features that have been omitted from the model, as well as what has been included. Decisions regarding the most appropriate assumption as to the behavior of the disturbances thus are seen as quite important, and as varying from problem to problem. One additional specification might be the counterpart of the mixed specification described above. In this alternative, there would be 4 free covariances and 2 covariances fixed at zero. In this project, we have explored only the first three specification alternatives described above. Figure 3 shows the structural equations for Models A and B, and the three alternative specifications on the disturbances covariance matrix.

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Figure 3 About Here
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Figure 3

Structural Model

notation

y_1 = ego values y_2 = peer values y_3 = ego achievement y_4 = peer achievement

x_1 = ego ability x_2 = ego SES x_3 = climate x_4 = peer ability x_5 = peer SES

Model A	Model B
$y_1 = b_{12}y_2 + g_{11}x_1 + g_{12}x_2 + g_{13}x_3 + u_1$	$y_1 = b_{12}y_2 + g_{11}x_1 + g_{12}x_2 + g_{13}x_3 + u_1$
$y_2 = b_{21}y_1 + g_{23}x_3 + g_{24}x_4 + g_{25}x_5 + u_2$	$y_2 = b_{21}y_1 + g_{23}x_3 + g_{24}x_4 + g_{25}x_5 + u_2$
$y_3 = b_{31}y_1 + b_{32}y_2 + g_{31}x_1 + g_{32}x_2 + g_{33}x_3 + u_3$	$y_3 = b_{31}y_1 + b_{34}y_4 + g_{31}x_1 + g_{32}x_2 + g_{33}x_3 + u_3$
$y_4 = b_{41}y_1 + b_{42}y_2 + g_{43}x_3 + g_{44}x_4 + g_{45}x_5 + u_4$	$y_4 = b_{42}y_2 + b_{43}y_3 + g_{43}x_3 + g_{44}x_4 + g_{45}x_5 + u_4$

Alternative Specifications for the Variance-Covariance Matrix of the Structural Disturbances

Fixed off-diagonals

	U_1	U_2	U_3	U_4	
U_1	?				
U_2	0	?			
U_3	0	0	?		matrix is symmetric; only lower triangle is shown
U_4	0	0	0	?	

Free off-diagonals

	U_1	U_2	U_3	U_4	
U_1	?				
U_2	?	?			
U_3	?	?	?		matrix is symmetric; only lower triangle is shown
U_4	?	?	?	?	

Mixed off-diagonals

	U_1	U_2	U_3	U_4	
U_1	?				
U_2	?	?			
U_3	0	0	?		matrix is symmetric; only lower triangle is shown
U_4	0	0	?	?	

Before going on to discuss the numerical results obtained when each of the models are estimated using the various specifications, we pause to note that, regardless of the specification imposed on the disturbances, both Model A and Model B satisfy the "order" condition for identifiability (Fisher, 1966). That is, each equation of each model has at least as many omitted predetermined variables as there are jointly dependent predictors used. However, Model A with free disturbance covariances fails the rank condition in equations 3 and 4. Thus, it is not fully identified unless some constraints are imposed on the disturbance covariance matrix.

Tables 2A and 2B show the results of estimating Model A and Model B respectively on the 1741 students, with the structural disturbances having all covariances fixed at zero. The estimates shown in these tables are obtained from the 'standardized' LISREL solution. In such solutions, each structural variable is rescaled by the program to have a variance equal to 1.0000. They thus correspond to the usual 'standardized' coefficient of the path analysis tradition.

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Table 2 About Here

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Neither of these models achieves an acceptable fit to the data. The explanatory power is lowest in the equation for ACADVFRN, as reflected in the disturbance variance of .9846 for that variable in both Model A and Model B. This disturbance variance is nearly as large as the total variance (1.0000). Considering the overall goodness-of-fit, it seems clear that Model B is a relatively better fit. That is, the chi-square

Table 2

N = 1,741

Standardized LISREL results; all disturbance covariances fixed at zero

A. No Reciprocal Causes Between Achievement

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.3542			+.1035	+.0652	-.0042		
2. ACADVFRN =	-.0748						-.0082	+.1800	+.1311
3. MATHOWN =	+.1608	+.1267			+.4199	+.1498	-.0918		
4. MATHFRN =	+.1081	+.2101					-.1001	+.4595	+.1918

chi square = 328.31 with 8 d.f.; probab = 0.0000

disturbance variances

LISREL

Ψ_{11} = 0.8931

Ψ_{22} = 0.9846

Ψ_{33} = 0.6544

Ψ_{44} = 0.5072

B. Reciprocal Causes

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.3542			+.1035	+.0652	-.0042		
2. ACADVFRN =	-.0748						-.0082	+.1800	+.1311
3. MATHOWN =	+.1411			+.2795	+.3690	+.1126	-.0440		
4. MATHFRN =		+.2209	+.1227				-.0917	+.4375	+.1764

chi square = 80.10 with 8 d.f.; probab = 0.0000

disturbance variances

LISREL

Ψ_{11} = 0.8931

Ψ_{22} = 0.9846

Ψ_{33} = 0.5790

Ψ_{44} = 0.4755

for Model A is 328.31, and the corresponding chi-square for Model B is 80.10. Although no formal statistical test can be performed to compare these two values, it seems clear that the fit of Model B, though not very close, is better than the fit of Model A.

In both models, the equations for ACADVOWN and ACADVFRN are the same. This is as we would expect, since by virtue of the disturbance specification those two equations are unconnected to any later equations. The estimated coefficients in the ACADVFRN equation are somewhat strange. That is, the coefficient for ACADVOWN in the ACADVFRN equation is negative (-.0748), which is contrary to any theoretical expectations. Also, the coefficients for the exogenous variables in the ACADVFRN equation are larger in magnitude than the corresponding coefficients in the ACADVOWN equation. These two patterns together suggest some methodological artifact tending to depress the estimated coefficient of ACADVOWN in equation 2, while raising the estimated coefficients of the exogenous variables.

The preceding models are, as noted earlier, highly constrained. Thus, their generally poor fit to the data, though disappointing, is not too surprising. We consider next the estimated results from the specifications in which all the covariances among the structural disturbances are allowed to be free. This specification is very relaxed; specifically, it cannot fail to reproduce perfectly the intercorrelations among the four jointly dependent variables. In fact, as mentioned, in Model A there are two underidentified equations. Yet, as a means of learning about the LISREL technique, an estimation was desirable. These specifica-

tions can be represented, and therefore estimated, using either LISREL or 2SLS. The results from a LISREL solution of these models (both Model A and Model B) are given in Tables 3A and 3B below. Inspection of these results will reveal that they also are quite strange. Several anomalies

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Table 3 About Here

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are present, both in the LISREL results and in the 2SLS results.

First, the LISREL output for Model A indicates that the "E matrix failed" to be positive definite. This is described by Jöreskog and Gruvaeus as usually indicating the model is underidentified. This result is a confirmation of our analysis which used the rank condition on the model. However, the rank condition is applicable only to models in which the measurement is treated as being exact. Thus, one important feature of the recent editions of the LISREL package is the provision of the warning about likely underidentification. For Model B, the LISREL output indicates no problem with the E matrix, but does reveal that the estimation algorithm failed to converge on a solution after 250 iterations. This outcome presents a puzzle, and perhaps a drawback of the LISREL technique.

The 2SLS results for these models show an interesting pattern. In both models, the solutions obtained by LISREL and by 2SLS are very similar for equations 1 and 2. For any practical purposes, the LISREL solution and the 2SLS solution are interchangeable, for both the ACADVOWN and

Table 3

N = 1,741

Standardized LISREL results; all disturbance covariances free

A. No Reciprocal Causes Between Achievement

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.6040			+.0797	+.0325	+.0047		
2. ACADVFRN =	+.5811						-.0057	+.1040	+.0602
3. MATHOWN =	## +.1725	+1.0650			+.3032	+.0729	-.0469		
4. MATHFRN =	## +.9831	+.1411					-.0934	+.3574	+.1217

chi square = 0.92 with 2 d.f.; probab = 0.6321

disturbance variances

	LISREL	2SLS
Ψ 11 =	0.9812	0.9728
Ψ 22 =	0.9578	0.9489
Ψ 33 =	1.5078	7.2455
Ψ 44 =	1.2175	1.2631

B. Reciprocal Causes

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.5985			+.0800	+.0370	+.0060		
2. ACADVFRN =	+.5603						-.0053	+.1026	+.0673
3. MATHOWN =	+1.1378			+.1803	+.2396	+.0412	-.0408		
4. MATHFRN =		+.9434	+.1721				-.0811	+.2967	+.0782

chi square = 0.56 with 2 d.f.' probab = 0.7565

disturbance variances

	LISREL	2 SLS
Ψ 11 =	0.9777	0.9728
Ψ 22 =	0.9461	0.9489
Ψ 33 =	1.5034	2.1627
Ψ 44 =	0.9623	7.6454

NOTE: ## indicates that these equations are not identified in this specification

the ACADVFRN equations. However, each of these structural equations accounts for very little of its outcome variable, whichever model we consider. This is also reflected in the small coefficients obtained for the exogenous variables.

Consider now Model A, equations 3 and 4. We note in Table 3A that the disturbance variance contributing to each of these is greater than the total variance of the variable. This is substantively startling, but nevertheless possible. Note also that one of the coefficients in equation 3 is greater than 1.0, which (though conceptually possible) seems quite uninterpretable. The 2SLS solution for this equation is quite different from the LISREL one, but equally strange and uninterpretable. From 2SLS, we obtain for equation 3 an estimated disturbance variance of 7.2455! Clearly, something is drastically wrong with this equation. The 2SLS coefficients for equation 3 likewise depart radically in magnitude and pattern from those given by LISREL. A similar situation occurs with equation 4, in that both solutions are strange and they differ greatly from each other, and the disturbance variances in either estimation method are greater than 1.0. This is of course not surprising since both of these equations are underidentified.

When we examine Model B closely, we again find that strange results have been obtained. In particular the LISREL algorithm has failed to converge. There is no obvious explanation for this. In this Model B estimation, although LISREL again produces an estimated disturbance variance greater than 1 (1.5034 here) for equation 3, the coefficients are not quite so extreme as they were for Model A. There is still a coefficient

greater than 1, but the 2SLS results are relatively similar to the LISREL results. For equation 4, LISREL produces what could be plausible results, whereas 2SLS produces very strange results.

We have worked to resolve these outcomes, and to understand them better, but with only partial success. In a rough intuitive sense, it appears that the problem lies mainly in the fact that ACADVOWN and ACADVFRN are not well accounted for. A related fact may be that the "instruments" for ACADVFRN in the ACADVOWN equation correlate higher with ACADVOWN than with ACADVFRN. This is not logically compatible with the constructed model.

However, at the moment we have not been able to explicate the specific causes of these bizarre patterns, despite various efforts to do so. This therefore remains a task for future research. In the remainder of this report, we shall not consider further the specification in which all 6 covariances are free.

The third specification we have estimated treats the values variables as predetermined with respect to the achievement equations. Equivalently, it sets 4 of the 6 covariances to zero, as indicated under the heading "mixed" in Figure 3.

The results from estimating this Model A and also Model B are shown in Table 4. They are generally quite close to those obtained from 2SLS.

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Table 4 About Here

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These results provide the first substantively interpretable conclusion.

Table 4

N = 1,741

Standardized LISREL results; some disturbance covariances fixed at zero

A. No Reciprocal Causes Between Achievement

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.6003			+.0793	+.0352	+.0052		
2. ACADVFRN =	+.5730						-.0043	+.1010	+.0670
3. MATHOWN =	+.1697	+.1327			+.3851	+.1369	-.1005		
4. MATHFRN =	+.1167	+.2250					-.1169	+.4243	+.1750

chi square = 145.13 with 6 d.f.; probab = 0.0000

disturbance variances

	LISREL	2SLS
Ψ 11 =	.9788	0.9728
Ψ 22 =	.9529	0.9489
Ψ 33 =	.6708	0.6455
Ψ 44 =	.5324	0.5049

B. Reciprocal Causes

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.6002			+.0793	+.0352	+.0052		
2. ACADVFRN =	+.5729						-.0043	+.1010	+.0671
3. MATHOWN =	+.1323			+.4041	+.3226	+.0919	-.0184		
4. MATHFRN =		+.1854	+.3418				-.0735	+.3735	+.1425

chi square = 9.34 with 6 d.f.; probab = 0.1555

disburbance variances

	LISREL	2SLS
Ψ 11 =	.9788	0.9728
Ψ 22 =	.9529	0.9489
Ψ 33 =	.5554	0.5552
Ψ 44 =	.4488	0.4487

For these data, Model B fits better than Model A, and indeed the fit of Model B is good enough to be tentatively accepted as not inconsistent with the data (p-value of Model B = .1555). This model thus could have generated these data. The patterns of the coefficients are interesting as well. One notable outcome is that the structural coefficient for school climate is consistently quite small, except in equation 4, and is in the unexpected direction for 3 of 4 equations in each model. Comparing equations 1 and 2 (from either model), we notice that the background variables (abstract reasoning, father's education, and climate) have slightly greater impact in the peer equation than in the ego equation. However, the reciprocal coefficients of one person's values on the values of the other person show that the impact of peer values on ego values is slightly greater than the impact of ego values on peer values. This may be in part an artifact of the way the "peer" variables have been defined. That is, the peer variables are averages over several students, and thus may be more stable (i.e., have less noise) than the corresponding variables for ego. The differences are in any case fairly small (.1697 - .1327 = .0370 for ego achievement on ego vs. peer values, and .2250 - .1167 = .1083 for peers' achievement on peer vs. ego values). For Model B, we have ego achievement dependent on peers' achievement with a coefficient of .4041; the corresponding coefficient in the peers' achievement equation is .3418.

To summarize, the principal interesting aspects of this particular comparison are: (1) Model B fits better than Model A; (2) the equations for ego and for peers are similar, as would be expected; (3) the net

impact of school climate is negligible, and perhaps even in the direction opposite to expectations. Before attempting to interpret these results in any detail, we first will present some additional results, in which the same substantive models are estimated with slightly different operationalizations, and on different case bases.

5.3 Estimation Results on Seniors Only, Using Average Friend

Because some of the theoretical rationale supporting our models depends on the development of close social bonds, we decided to carry out an estimation of Model A and Model B only on the seniors in the twenty high School data set. Also, previous studies (Karweit, 1976) have indicated that peer processes differ between boys and girls. Consequently, it was decided to carry out the estimation separately for males and for females. A 50% sample was used to allow replication.

These results are presented first for the version of the model in which all 6 disturbance covariances are zero. Table 5 shows the results for males (N = 594), and Table 6 shows the corresponding results for females (N = 679). The correlation matrices are given in Appendix A as

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Tables 5 and 6 About Here

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Tables A.2 and A.3. In each case, the results are the 'standardized' LISREL solution. For this specification of the disturbance covariances, there is no corresponding 2SLS solution.

Two points are immediately apparent concerning Tables 5 and 6.

Table 5

Male Seniors, N = 594

Standardized LISREL results; all disturbance covariances fixed at zero

A. No Reciprocal Causes Between Achievement

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.8033			+.0124	-.0415	+.0777		
2. ACADVFRN =	-.6661						+.0547	+.3453	+.0223
3. MATHOWN =	+.1290	+.1569			+.4453	+.0818	+.0644		
4. MATHFRN =	+.1286	+.2513					+.0636	+.3972	+.1705

chi square = 126.38 with 8 d.f.; probab = 0.0000

disburbance variances

LISREL

Ψ_{11} = 1.1452

Ψ_{22} = 1.7220

Ψ_{33} = 0.7070

Ψ_{44} = 0.5878

B. Reciprocal Causes

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.8037			+.0123	-.0415	+.0777		
2. ACADVFRN =	-.6668						+.0547	+.3455	+.0223
3. MATHOWN =	+.1238			+.2029	+.4106	+.0687	+.0394		
4. MATHFRN =		+.2455	+.2100				+.0591	+.3804	+.1474

chi square = 42.53 with 8 d.f.; probab = 0.0000

disturbance variances

LISREL

Ψ_{11} = 1.1456

Ψ_{22} = 1.7233

Ψ_{33} = 0.6452

Ψ_{44} = 0.5317

Table 6

Female Seniors, N = 679

Standardized LISREL results; all disturbance covariances fixed at zero

A. No Reciprocal Causes Between Achievement

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		-.1346			+.1620	+.0907	-.1418		
2. ACADVFRN =	+.3580						+.0478	+.1641	-.0515
3. MATHOWN =	+.1337	+.1058			+.4014	+.2309	+.1328		
4. MATHFRN =	+.0259	+.2056					+.1252	+.4098	+.2815

chi square = 122.92 with 8 d.f.; probab = 0.0000

disturbance variances

LISREL

$\Psi 11$ = 1.0329

$\Psi 22$ = 0.9344

$\Psi 33$ = 0.6547

$\Psi 44$ = 0.5465

B. Reciprocal Causes

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		-.1344			+.1620	+.0907	-.1418		
2. ACADVFRN =	+.3579						+.0478	+.1641	-.0516
3. MATHOWN =	+.1401			+.2477	+.3645	+.1729	+.0860		
4. MATHFRN =		+.1916	+.1218				+.1097	+.3926	+.2539

chi square = 27.52 with 8 d.f.; probab = 0.0006

disturbance variances

LISREL

$\Psi 11$ = 1.0328

$\Psi 22$ = 0.9344

$\Psi 33$ = 0.5903

$\Psi 44$ = 0.5081

First, in each of them, Model B shows a substantially better fit than Model A. That is, the achievements of ego and of peers are better predicted by a model positing that such achievements depend on own values and on the achievements of the other, than by a model positing that they depend on own values and the values of the other person. This result is consistent with the earlier results obtained for a sample of all the students in Table 2. Considering the weak explanatory power of the model concerning either ACADVOWN or ACADVFRN, this is not surprising. The second noteworthy point about Tables 5 and 6 is that some of the estimated disturbance variances are greater than 1.0. This again is a paradox and suggests the weakness of these models to explain values. Notice that this occurs for equations 1 and 2 of the model for Males (Table 5) and also for equation 1 of the model for Females (Table 6). It did not occur in the corresponding analyses of the N = 1741 data (Table 2). At the moment, we do not have a fully satisfactory explanation for this pattern, although we have given it some consideration. Our general conclusion is that when the two endogenous variables are much more dependent on each other than they are on the exogenous predictors, there is a tendency for an "explosive" shift in the coefficients to occur. Note also that in these tables, the signs of peers' values as predictors of ego values are not the same for the two equations. This is contrary to all theoretical expectations. We feel that it is an artifact of the poor fit, and that the negative coefficient of ego values in the equation for peer values in Table 5 is counterbalanced by the unusually large positive coefficient for ABSTFRN in the same equation. A similar point

holds perhaps with regard to the negative coefficient for peer values in the ego values equation of Table 6. That negative coefficient is perhaps offset by the somewhat large coefficient of ABSTOWN. Finally, we note that in general there are considerable differences in the parameter values for males as compared with females.

On balance, then, we conclude that the estimation using the "all fixed" specification for the covariances of the disturbances is not satisfactory.

Thus, we turn next to the alternative specification, in which 2 of the 6 disturbance covariances are left free, while the remaining 4 are fixed. The results for these estimations (standardized solutions from LISREL) are given in Table 7 for male seniors (N = 594), and in Table 8 for female seniors (N = 679).

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Tables 7 and 8 About Here

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These results again contain "good news and bad news." The good news is that once again Model B fits better than Model A. With this specification on the disturbance covariances, indeed, the fit of Model B is acceptable for males (p = .1348), and highly acceptable for females (p = .4035). The bad news is that once again the estimated disturbance variances are greater than 1.0 for ACADVOWN and ACADVFRN among males (Table 7), and for ACADVFRN among females (Table 8). In addition, we note a further complication for the results on the males. Both Model A and Model B using this data fail to converge on a solution after 250 iterations.

Table 7

Male Seniors, N = 594

Standardized LISREL results; some disturbance covariances fixed at zero

A. No Reciprocal Causes Between Achievement

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.7782			+.0028	+.0009	+.0682		
2. ACADVFRN =	+1.2387						-.0846	+.0075	+.0001
3. MATHOWN =	+.1362	+.1670			+.3864	+.0692	+.0728	+.3719	+.1417
4. MATHFRN =	+.1363	+.2632					+.0778	+.3719	+.1417

chi square = 51.33 with 6 d.f.; probab = 0.0000

disturbance variances

	LISREL	2SLS
Ψ 11 =	1.1226	1.1291
Ψ 22 =	1.7659	1.5012
Ψ 33 =	0.7312	0.6905
Ψ 44 =	0.6115	0.5879

B. Reciprocal Causes

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.7790			+.0025	+.0008	+.0682		
2. ACADVFRN =	+1.2432						-.0849	+.0066	+.0001
3. MATHOWN =	+.1090			+.3775	+.3461	+.0490	+.0168		
4. MATHFRN =		+.2076	+.4557				+.0381	+.3112	+.1317

chi square = 9.77 with 6 d.f.; probab = 0.1348

disturbance variances

	LISREL	2SLS
Ψ 11 =	1.1235	1.1291
Ψ 22 =	1.7746	0.5012
Ψ 33 =	0.6014	0.6004
Ψ 44 =	0.5169	0.5155

Table 8

Female Seniors, N = 679

Standardized LISREL results; all disturbance covariances fixed at zero

A. No Reciprocal Causes Between Achievement

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.3032			+.1074	+.0661	-.1372		
2. ACADVFRN =	+.7317						+.0920	+.1355	-.0534
3. MATHOWN =	+.1429	+.1131			+.3722	+.2061	+.1468		
4. MATHFRN =	+.0298	+.2155					+.1433	+.3885	+.2556

chi square = 59.86 with 6 d.f.; probab = 0.0000

disturbance variances

	LISREL	2SLS
Ψ 11 =	0.9156	0.9145
Ψ 22 =	1.1557	1.1762
Ψ 33 =	0.6799	0.6515
Ψ 44 =	0.5702	0.5429

B. Reciprocal Causes

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.3033			+.1074	+.0661	-.1372		
2. ACADVFRN =	+.7315						+.0920	+.1355	-.0534
3. MATHOWN =	+.1171			+.3645	+.3367	+.1538	+.0564		
4. MATHFRN =		+.1686	+.2974				+.0885	+.3493	+.2202

chi square = 6.18 with 6 d.f.; probab = 0.4035

disturbance variances

	LISREL	2SLS
Ψ 11 =	0.9156	0.9145
Ψ 22 =	1.1555	1.1762
Ψ 33 =	0.5722	0.5717
Ψ 44 =	0.4809	0.4806

Since this outcome did not occur on either the N = 1741 or on the female seniors (N = 679), we must conclude that under certain conditions on the input data, LISREL will not be able to fit a clear solution. We suspect that this happens because the input data correlation matrix for the results in Table 7 implies that the disturbance into equation 1 is correlated .9998 (essentially perfectly) with the disturbance into equation 2. Thus, the LISREL algorithm cannot choose a direction of change in its attempt to maximize fit. Perhaps we could visualize it as attempting to climb a ridge. One continually slides off either side and merely climbs back onto the ridge, rather than along it. A reflection of this difficulty may be the fact that in these results we obtain for the ·es (Table 7) coefficients of 1.24 for ACADVOWN in the ACADVFRN equation. It seems likely that these coefficients are larger than is reasonable.

The results for females also contain one disturbance variance greater than 1.0, but the intercorrelation of the LISREL estimated disturbances is not extreme (= .7099) for equations 1 and 2. The coefficients, however, indicate a considerably greater dependence of ACADVFRN on ACADVOWN than vice versa. This seems implausible on theoretical grounds.

The models shown in Tables 7 and 8 are amenable to solution via 2SLS, and such solutions were performed. For male seniors, the 2SLS results are fairly close to the LISREL results, including the estimated disturbance variances greater than 1.0. One potentially interesting discrepancy concerns the sizes of the disturbance variances. The 2SLS result gives a somewhat smaller disturbance variance for ACADVFRN (1.5012) than does LISREL (1.7659), and also has a coefficient not as large for

ACADVOWN in the ACADVFRN equation (1.08 instead of 1.24). This suggests that the 2SLS method is more "robust" than full information (LISREL) in the presence of misspecification--a property well known to econometricians.

When the 2SLS results for females are compared to those from LISREL, we find very close similarity. Thus, it appears that, even with one disturbance variance greater than 1.0, the two methods are quite similar when they both are applicable fully to the data.

5.4 Estimated Results on Male Seniors Only, Using Individual Friends

A number of the estimates results obtained in the preceding sections contain puzzles and surprises, both in methodological terms and in substantive terms as well. Our suspicion was that two features of our operationalization may have contributed to these anomalies, and so we undertook an additional analysis, using an alternative operationalization of the two substantive models.

This operationalization differed from the previous ones in two ways. First, since it had become apparent that the index used to measure scholastic values was not well accounted for by the models, we decided to substitute for that index the single response to the question (#145): "How much do you personally admire other students who are very bright in school?" Second, instead of using the average of several named peers, we used the response given by the single peer named first in a sociometric choice question.

We describe now the results where the peer relation is that of person first named as friend by ego. The correlations appear in Appendix A as Table A.4. Table 9 shows the results of estimating Models A and B

under this operationalization, and with the specification that all the dis-

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Table 9 About Here

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turbance covariances are zero. There are 609 cases, since a 50% sample was used to allow replication.

Examining Table 9, we note first that the chi-square for Model B is considerably smaller than the chi-square for Model A, indicating once again a superior fit of Model B. However, neither model fits very closely.

We note also that there are no disturbance variances greater than 1.0, and no coefficients greater than 1.0. Thus, these models contain no immediate anomalies.

Closer inspection of the coefficients, however, indicates some unexpected results in Model A. For example, the coefficient for ACADVFRN (here the item on admiring brightness) in the equation for ACADVOWN is negative. This is different from the results obtained when the seven-item index of ego values was used, and when average friend was used. Perhaps this negative relation is an indication that the index used in the earlier estimations was not really homogeneous in its behavior. A second problem is the small percentage of variation accounted for in either the ACADVOWN or ACADVFRN equation. This is complicated further by the disparate pattern of coefficients in these two equations, although the equations substantively are quite parallel in meaning. Still another surprising pattern in these results occurs in the equations for MATHOWN and MATHFRN.

Table 9

Male Seniors, Choice One, N = 609

Standardized LISREL results; all disturbance covariances fixed at zero

A. No Reciprocal Causes Between Achievement

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		-.0415			+.1204	+.0985	+.0369		
2. ACADVFRN =	+.1304						-.0126	+.0878	+.0747
3. MATHOWN =	+.1131	+.0900			+.4580	+.1393	+.0756		
4. MATHFRN =	+.1272	+.0860					+.1049	+.3939	+.1248

chi square = 78.64 with 8 d.f.; probab = 0.0000

disturbance variances

	LISREL
$\Psi 11$ =	0.9752
$\Psi 22$ =	0.9769
$\Psi 33$ =	0.6725
$\Psi 44$ =	0.7428

B. Reciprocal Causes

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		-.0417			+.1204	+.0985	+.0369		
2. ACADVFRN =	+.1360						-.0126	+.0878	+.0747
3. MATHOWN =	+.0994			+.1509	+.4434	+.1291	+.0573		
4. MATHFRN =		+.0782	+.1712				+.0888	+.3824	+.3990

chi square = 27.35 with 8 d.f.; probab = 0.0006

disturbance variances

	LISREL
$\Psi 11$ =	0.9753
$\Psi 22$ =	0.9770
$\Psi 33$ =	0.6296
$\Psi 44$ =	0.6973

Notice that MATHOWN depends somewhat more on ACADVOWN than on ACADVFRN. This is as expected. However, MATHFRN depends less on ACADVFRN than on ACADVOWN. This is contrary to our expectations, and inconsistent with the substantive parallelism between the equations.

Model B shows identical patterns in equations 1 and 2, which is as the mathematics of the estimation would require. Its results for equations 3 and 4 seem plausible enough.

Next we consider the estimation results for the same two models, and the same operationalization, but where the specification has been changed to allow 2 of the 6 disturbance covariances to be free. These results are presented in Table 10. Note that this model may also be solved via two-stage least squares.

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Table 10 About Here

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Inspection of Table 10 indicates once again a better overall fit for Model B (though in this instance the chi-squares are fairly close). However, it also shows the presence of disturbance variances greater than 1.0 for equations 1 and 2 of both models. The coefficients in Model A are all very plausible, with one exception. In the equation for MATHFRN, the coefficient for ACADVOWN (+.1308) is larger than the coefficient for ACADVFRN (+.0917). This seems contrary to any reasonable theory.

For both Models A and B, equations 1 and 2 in Table 10 give a reasonable picture. They indicate that the scholastic values held by the

Table 10

Male Seniors, Choice One, N = 609

Standardized LISREL results; some disturbance covariances fixed at zero

A. No Reciprocal Causes Between Achievement

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.4744			+.0852	+.0724	+.0380		
2. ACADVFRN =	+.4454						-.0327	+.0749	+.0493
3. MATHOWN =	+.1188	+.0933			+.4412	+.1224	+.0856		
4. MATHFRN =	+.1308	+.0917					+.1157	+.3791	+.0915

chi square = 25.34 with 6 d.f.; probab = 0.0003

disturbance variances

	LISREL	2SLS
$\Psi 11$ =	1.1093	1.1014
$\Psi 22$ =	1.0986	1.0936
$\Psi 33$ =	0.6879	0.6702
$\Psi 44$ =	0.7568	0.7372

B. Reciprocal Causes

dependent	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN	FEDUFRN
1. ACADVOWN =		+.4746			+.0852	+.0724	+.0380		
2. ACADVFRN =	+.4454						-.0327	+.0749	+.0493
3. MATHOWN =	+.1008			+.2865	+.4123	+.1221	+.0385		
4. MATHFRN =		+.0817	+.2660				+.0695	+.3542	+.1049

chi square = 17.90 with 6 d.f.; probab = 0.0065

disturbance variances

	LISREL	2SLS
$\Psi 11$ =	1.1094	1.1014
$\Psi 22$ =	1.0986	1.0937
$\Psi 33$ =	0.6119	0.6112
$\Psi 44$ =	0.6787	0.6777

student are influenced by the student's own ability and by his father's education, though these influences are small. The influence of overall school climate on these values is quite small, and is in fact of opposite sign in the two equations. The most plausible interpretation is that the climate in the school does not affect student values. Of course, it should be kept in mind that the climate variable is measured at the school level, and so cannot possibly account for any of the within-school variation in values.

Equations 3 and 4 have different forms in Model A as compared with Model B. The general picture, however, is that own values play a modest role in affecting achievement (standardized coefficients averaging about .10). The most powerful impact on achievement, not surprisingly, comes from the ability measures. When Model B is compared with Model A, we note that the influence of the other person's achievement averages about .27 standardized coefficient, in Model B. The influence of other person's values averages about .11, from Model A. Other variables remain roughly the same in impact between the two models, except climate, whose impact is reduced in Model B.

6. Conclusions

In this section we discuss first the substantive interpretation of the results just presented, and then go on to outline several implications. These implications concern the general nature of the challenge confronting an investigator who uses powerful statistical tools to estimate complex models of social production processes.

The one pervasive finding in these analyses is that Model B fits

the datasets more closely than does Model A. At first sight, this appears to indicate that school achievement outcomes are more dependent on the corresponding achievement of one's peer associates than they are on the scholastic values of those same associates. This is a theoretically reasonable conclusion, and is an interpretation entirely consistent with the results observed. This would be in keeping with results and interpretations made by Coleman as early as 1961 on the ambivalence felt by high school students regarding the value of academic performance, and the frequent norms against endorsing such values visibly. There is no way to reject this interpretation based on these data.

However, it is not the only reasonable interpretation. An alternative view would be as follows. The operationalizations used here for measuring the scholastic values of students probably are inadequate to the analysis demands placed on them. That is, it may well be that these measures are "noisy" (unreliable) and only partly valid as evidence of the particular scholastic values that do influence the achievements of one's associates. There is no way the data can refute this interpretation either.

The first interpretation speaks directly to the main substantive issues that were originally posed for study in this project. The second interpretation, on the other hand, redirects attention. It implies that a reformulation of theorizing about the meaning of the concept "scholastic values" is required. Any intelligent choice between these interpretations would require the development and execution of a variety of additional empirical analyses, some of which might not even be possible with

these data. Thus, we are left, in this respect, with a single clear finding, but two defensible interpretations thereof.

A first implication from this work concerns the alternative constraints imposed on the variance-covariance matrix of the disturbances in the two models. Notice that, when no constraints are imposed on those covariances, Model A has 2 equations which are not identified. This is true even though the model is quite straightforward, and even though the equations do pass the "order" condition.

The lesson here is that one should always apply the rank condition, even when the order condition is satisfied. Identifiability is clearly a problematic issue, and not at all obvious on inspection, even to a person thoroughly familiar with the substantive issues. In this case, the two models under study had been developed by one of the present authors, but the problem with equations 3 and 4 of Model A was revealed only by the formal application of the rank test. Incidentally, the two-stage least squares method gives no clue when the rank condition is not met. The LISREL procedure, on the other hand, does give the "E matrix failure" warning. Thus, it is preferable. Also, LISREL allows for explicit specification of constraints on the disturbance covariances, and so makes clear how the identifiability is being achieved. In our case, the particular set of zero covariances that were specified in the "mixed" specification amounts, in econometric terminology, to treating ACADVOWN and ACADVFRN as predetermined whenever they (or either of them) appear as a direct predictor in the equations for MATHOWN or MATHFRN.

One recurrent outcome in these results was the estimation of a disturbance variance greater than the original variance of the variable in question. This seems paradoxical. Yet, it is possible, and in fact is one consequence of our use (unavoidably) of what may be called "weak" instrumental variables. This idea can best been seen, roughly, by keeping in mind the general idea that 2SLS can be regarded as an instrumental variable technique. Usually, the instrumental variable constructed by 2SLS is a fairly adequate substitute (both in terms of its reliability and its validity) for the original variable (the included endogenous predictor). However, when the instrument is very weak, or of poor validity, one of the consequences is that it simply cannot be made to contribute, within the constraints of the algorithm, enough variance to the outcome variable. Thus, the shortage has to be made up by the disturbance contribution. This pattern of results apparently has never been discussed in the literature, and so further exploration of the conditions under which it may appear--and of the characteristics of instrumental variables--is one important direction for future research. Comparison of LISREL and 2SLS in these respects should be a part of any such research.

One further topic emerging from this set of estimations is the occurrence of nonconvergence of the LISREL algorithm in several instances (cf. Table 1). These failures clearly depend on the interaction between data and model content. The details remain essentially a puzzle, but this is an additional point deserving of attention, since the LISREL approach otherwise has great attractiveness.

In overall conclusion, then, our efforts have yielded some definite findings about the empirical impact of values and peer achievement on one another. They have also highlighted several logically important but obscure aspects of estimation using structural modeling techniques. Further research, substantive and methodological, will clarify the outlines now visible.

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Table A.1

N=1741

COVARIANCES OF THE Y-VARIABLES (SYY)

	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN
1 ACADVOWN	1.0000000			
2 ACADVFRN	0.3105871	1.0000001		
3 MATHOWN	0.2949648	0.2604516	1.0000000	
4 MATHFRN	0.2780559	0.3834521	0.5492502	1.0000000

COVARIANCES OF THE X AND Y-VARIABLES (SXY)

	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN
1 ABSTOWN	0.1694269	0.1449635	0.5058833	0.3230430
2 FEDUOWN	0.1297292	0.1139882	0.3049686	0.2934423
3 ABSTFRN	0.1577594	0.2120670	0.3661322	0.6003119
4 FEDUFRN	0.1362226	0.1819161	0.3196963	0.4271573
5 CLIMATE	-0.0632673	-0.0828232	-0.1995969	-0.2762640

COVARIANCES OF THE X-VARIABLES (SXX)

	ABSTOWN	FEDUOWN	ABSTFRN	FEDUFRN
1 ABSTOWN	1.0000000			
2 FEDUOWN	0.2266885	1.0000000		
3 ABSTFRN	0.2637595	0.2330328	1.0000000	
4 FEDUFRN	0.2293549	0.4014188	0.3225422	1.0000000
5 CLIMATE	-0.1069606	-0.2905882	-0.1855997	-0.3502654

COVARIANCES OF THE X-VARIABLES (SXX)

	CLIMATE
5 CLIMATE	1.0000001

Table A.2

N=594

COVARIANCES OF THE Y-VARIABLES (SYY)

	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN
1 ACADVOWN	1.0000000			
2 ACADVFRN	0.3073523	1.0000000		
3 MATHOWN	0.2386231	0.2626911	1.0000000	
4 MATHFRN	0.3015797	0.3957287	0.5186679	1.0000000

COVARIANCES OF THE X AND Y-VARIABLES (SXY)

	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN
1 ABSTOWN	0.1209142	0.1342601	0.4907055	0.3039635
2 FEDUOWN	0.0510024	0.0878775	0.1706838	0.1886071
3 CLIMATE	0.0964173	0.0356361	0.1345833	0.1835895
4 ABSTFRN	0.1882318	0.2311577	0.2581192	0.5264744
5 FEDUFRN	0.0868710	0.0630158	0.2065539	0.3111878

COVARIANCES OF THE X-VARIABLES (SXX)

	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN
1 ABSTOWN	1.0000000			
2 FEDUOWN	0.1205875	1.0000000		
3 CLIMATE	0.0726454	0.2619585	1.0000000	
4 ABSTFRN	0.1765422	0.1384684	0.1099853	1.0000000
5 FEDUFRN	0.0938159	0.2830514	0.3223395	0.2345266

COVARIANCES OF THE X-VARIABLES (SXX)

	FEDUFRN
5 FEDUFRN	1.0000000

Table A.3

N=679

COVARIANCES OF THE Y-VARIABLES (SYY)

	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN
1 ACADVOWN	1.0000000			
2 ACADVFRN	0.2424154	1.0000000		
3 MATHOWN	0.2181067	0.2089574	1.0000000	
4 MATHFRN	0.1006553	0.2954039	0.5111178	1.0000000

COVARIANCES OF THE X AND Y-VARIABLES (SXY)

	ACADVOWN	ACADVFRN	MATHOWN	MATHFRN
1 ABSTOWN	0.1493591	0.1192882	0.4739131	0.2556539
2 FEDUOWN	0.0587407	0.0917573	0.3432681	0.3577297
3 CLIMATE	-0.1060020	0.0143298	0.2152495	0.2826613
4 ABSTFRN	0.0753115	0.1800863	0.2881357	0.5572797
5 FEDUFRN	0.0267537	0.0290272	0.3413053	0.4663992

COVARIANCES OF THE X-VARIABLES (SXX)

	ABSTOWN	FEDUOWN	CLIMATE	ABSTFRN
1 ABSTOWN	1.0000000			
2 FEDUOWN	0.1395803	1.0000000		
3 CLIMATE	0.0664916	0.2983683	1.0000000	
4 ABSTFRN	0.1602922	0.2334535	0.1399620	1.0000000
5 FEDUFRN	0.1653049	0.4674098	0.3581153	0.3291580

COVARIANCES OF THE X-VARIABLES (SXX)

	FEDUFRN
5 FEDUFRN	1.0000000

Table A.4

N=609

COVARIANCES OF THE Y-VARIABLES (SYY)

	PADIQOWN	PADIQ1	MATHOWN	MATH1
1 PADIQOWN	1.0000000			
2 PADIQ1	0.1015521	1.0000000		
3 MATHOWN	0.2127977	0.1464491	1.0000000	
4 MATH1	0.1870512	0.1577569	0.3994260	1.0000000

COVARIANCES OF THE X AND Y-VARIABLES (SXY)

	PADIQOWN	PADIQ1	MATHOWN	MATH1
1 ABSTOWN	0.1435973	0.0726750	0.5205364	0.1936249
2 FEDUOWN	0.1332114	0.0710374	0.2813200	0.1877234
3 CLIMATE	0.0879959	0.0257408	0.2055822	0.1852181
4 ABST1	0.0863230	0.1127941	0.1778049	0.4475108
5 FEDU1	0.0688811	0.0980056	0.2447377	0.2463799

COVARIANCES OF THE X-VARIABLES (SXX)

	ABSTOWN	FEDUOWN	CLIMATE	ABST1
1 ABSTOWN	1.0000000			
2 FEDUOWN	0.2079527	1.0000000		
3 CLIMATE	0.1540937	0.3407216	1.0000000	
4 ABST1	0.1403088	0.0973018	0.0919525	1.0000000
5 FEDU1	0.1498460	0.2166889	0.2513504	0.2003334

COVARIANCES OF THE X-VARIABLES (SXX)

	FEDU1
5 FEDU1	1.0000000